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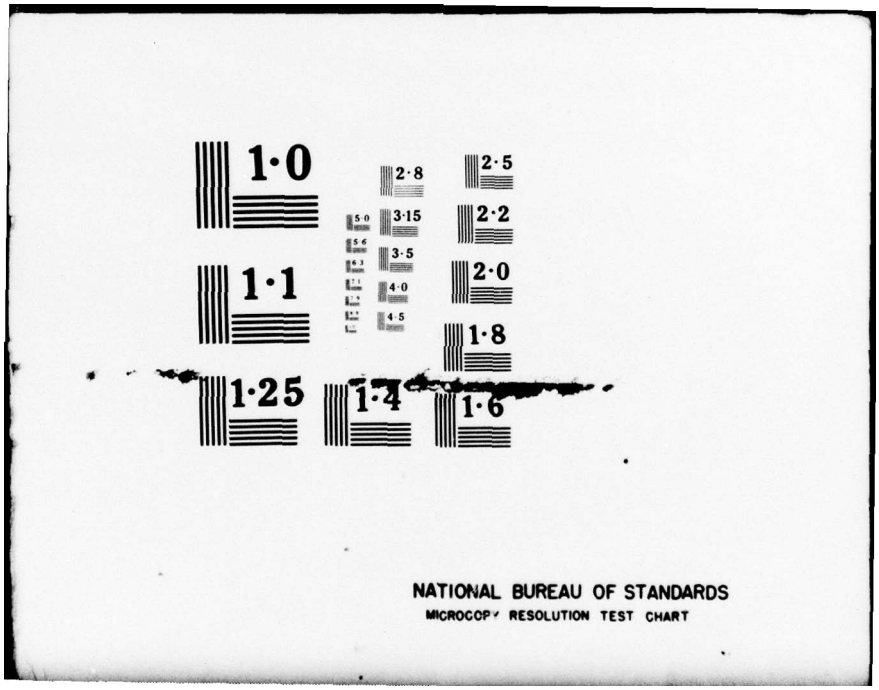
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SURVEY OF ARMY MOBILE POWER PLANT POLLUTION REQUIREMENTS

FINAL REPORT
AFLRL NO. 93

by
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Prepared by

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for

U. S. Army Mobility Equipment Research and Development Command
Energy and Water Resources Laboratory
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This report reviews and summarizes the past work that has been done by the Army to relate emissions to fuel composition, the hardware performance factors, the emissions regulations as they vary from state to state, the relation of those regulations to Army operations and the areas where additional action is warranted.

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INTRODUCTION

This report reviews and summarizes the past work that has been done by the Army to relate emissions to fuel composition, the hardware performance factors, the emissions regulations as they vary from state to state, the relation of those regulations to Army operations, and the areas where additional action is warranted.

BACKGROUND

With the enactment of the National Environmental Policy Act of 1969, P.L. 91, a new factor was introduced into the Army's scheme of planning and operation. Again, with Executive Order 11507 and subsequent orders, the direction and responsibility of Army facilities to "provide leadership in the nationwide effort to protect and enhance the quality of our air and water resources" was clearly shown. The Army did indeed respond with the Army Materiel Command formulating a plan to comply in every area possible. Of prime consideration throughout this mass effort was the national security and absolute necessity to maintain combat effectiveness. Executive Order 11507 provided for exemption of tactical and combat equipment from compliance with standards if compliance impairs combat capability.

A result of this effort was AMC regulation AMCR 11-5, July 1974, on Environmental Enhancement and Pollution Abatement. Section 10C(1) on ground vehicles states that tracked vehicles are excluded from the Clean Air Act, and certain other off-road combat and combat-support type vehicles are not required to meet emissions standards since they do not fall within the Clean Air Act definition of motor vehicles. Appendix H of AMCR 11-5 lists those exempted vehicles.

The only piece of Army equipment that falls in the controlled area of the Clean Air Act is the 1/4-Ton Truck, 4 × 4, M151A2, commonly referred to as "the jeep." Commencing in late 1973, the M151A2 engine was produced with a "clean-air" system so that the engine was EPA certified. This was apparently the maximum modification which could be made without seriously hampering the performance of the vehicle. This vehicle did not meet 1975 emission standards and, as a result, was granted an exemption which will be in effect until 1 January 1979.

With the increased influx of commercial vehicles into the Army fleet, there has been a similar increase in the number of vehicles which have emissions controls. This is apparent in sedans, vans, and the recently acquired fleets of pickup trucks. If the commercial vehicle falls into a regulated category, then the vehicle delivered to the Army has the necessary controls and is certified by the engine or vehicle manufacturer.

There are other areas of mobile power plant pollution in which the Army is concerned. Within the last decade, there has been great concern expressed over the means of disposing of used engine oils, both from military and nonmilitary sources. Originally the concern was antipollution oriented, but in recent years, economic and conservation reasons have

evolved for extending oil drain intervals, eliminating seasonal drains, development of no-drain or sealed-crankcase concepts, and recycling of used engine oils as reusable lubricants. Incentives to develop this lubrication technology were never as strong as they are currently because of our declining petroleum reserves.

There has also been significant interest in improving fuel economy and reducing maintenance costs by monitoring exhaust emissions and using the data as diagnostic information to improve performance. The reduction in the emissions would be primary, with the savings in fuel and maintenance costs as secondary.

CURRENT WORK

In order to reduce pollution by conserving engine oils, the lubricant-related programs at the U.S. Army Fuels and Lubricants Research Laboratory can be divided into four approaches:

- Improvements in oil base stock and formulations;
- Reduction of engine oil degradation by reducing engine severity through hardware modifications;
- Evaluation and improvement of engine oil recycling technology; and
- Development of lubricants for applications in future engines or fuels.

Advances in engine oil base stocks and additive formulations during the last forty years have extended the oil drain interval from 1000 miles to as much as 12,000 miles with the present MIL-L-2104C/MIL-L-46152 lubricants. Continuing efforts in this area will undoubtedly increase the oil drain intervals. But as oil drain intervals are extended, the seasonal drain requirements of single viscosity lubricants become limiting factors. Ongoing work at AFLRL has been aimed at developing multiviscosity base stocks (primarily synthetics) and viscosity index improver additives for use in all of the military fleet. During the period from 1970 through 1975, a new arctic engine oil specification was developed for military combat equipment. These lubricants, formulated with synthetic hydrocarbon or ester base stock material, have shown superior performance in ground equipment in arctic operation. The lubricants, with their inherent high viscosity index, appear well suited to other nonarctic applications where rapid and wide ambient temperature changes are experienced. As a result, fleet tests using this oil type are being conducted at Ft. Carson, Colorado.

Another area of research has been in evaluating methods of reducing the rate at which engines degrade their lubricant. Much work done at AFLRL and elsewhere has shown that the primary causes of engine oil degradation are blowby and heat. Since the oil is used to help cool the pistons, little can be done about heat, but blowby is the result of imperfect sealing of the combustion chamber. If blowby could be eliminated or substantially reduced, then the engine oil should degrade more slowly. By increasing or eliminating the oil-drain

interval, this would substantially reduce the amount of used oil that must be discarded and would also potentially reduce the demand for virgin oil.

A series of dynamometer evaluations and in-vehicle road tests with modified L-141 engines have resulted in the development of a set of piston rings which appear to reduce engine blowby as much as 80 percent and decrease engine-oil degradation 50 percent or more during medium- to high-temperature operation. These low- blowby rings, in conjunction with a high quality level single-grade MIL-L-2104C/MIL-L-46152 qualified oil, appear to make no-drain operation feasible for the 32,000-km (20,000-mile) expected life of the M151 vehicle when operated in a temperate zone where seasonal drains are unnecessary. However, these rings do not allow no-drain operation in areas where wide temperature extremes dictate seasonal drains of the single-grade oil required by the M151 vehicle lubrication order. Additional fleet tests of one to three M151 vehicles equipped with these piston rings are to be included with the testing being performed at Ft. Carson, Colorado. These field tests are being conducted using the Army's synthetic (multiviscosity) arctic lubricant to evaluate potential sealed-crankcase operation feasibility.

These two programs are part of the long-range development of a single all-purpose engine lubricant which can be used throughout the tactical and administrative fleet on a year-round, no-drain basis. The obvious advantages in procurement-costs savings, reduced maintenance costs, reduction in distribution problems, and increased combat/tactical equipment readiness make this goal highly desirable.

At the present time, the Army alone produces about 10,000,000 gallons of drained engine oil annually. Disposal methods range from burning in heating plants to dumping on the ground. The U.S. Army Fuels and Lubricants Research Laboratory is presently evaluating methods of recycling this drained oil back into useful lubricants and help conserve a nonrenewable natural resource.

Two commercial recycled engine oils were subjected to qualification engine testing to determine their actual performance level. Both oils failed nearly all the specified engine tests, pointing to the need for additional work in this area if MIL-lubricant specifications are to permit the use of recycled lube stocks. In pursuing this objective jointly with the U.S. Environmental Protection Agency and the National Bureau of Standards, a number of rerefined base oils submitted by the Association of Petroleum Rerefiners are being analyzed by the Army. From these base oils, a series of MIL-L-46152 candidate oils will be formulated and then subjected to the standard qualification engine tests to determine if MIL-L-46152 performance can be achieved.

Another area of concern is the possible use of fuels from unconventional crude oils. As increased pressure is brought to bear on available petroleum resources, the U.S. dependence on imported oil increases. In light of the oil embargo of the early 1970's, great interest has been developed in the utilization of coal and oil shale as a source of oils from which motor fuels could be produced. As engineering models and pilot units are developed and tested, the demand for larger units appears to be increasingly inevitable. However, the products from these units are not expected to always be as high in quality as that found in specification grade petroleum fuels. These off-spec products could and may well find their

way into supply systems and particularly into the Army fuel supply, either as a test of the fuels' performance, or as a matter of necessity in the event of a national energy or fuel crisis. The disturbing fact is that little or nothing is known of the effects on exhaust emissions from Army engines operating on fuels from unconventional crude oils. This is an area that needs to be and will be addressed when such fuels are available for testing.

Another area of significant activity is the evaluation of the White 163-cu. in. stratified charge engine which is designed as a direct replacement in the M151 1/4-ton truck. This engine has been evaluated and optimized at SwRI under a contract with TARADCOM. The work has been completed, and the final report is in preparation. In general, the engine appears to show great promise in broad fuel tolerance, significant reduction in emissions compared to the current 141-cu. in. "jeep" engine and much improved fuel economy. The engine's ability to operate on diesel fuel as well as gasoline will meet the goal of complete dieselization of the tactical and combat fleet for one fuel operation. However, emissions from this engine have been determined only on one reference gasoline and one reference diesel fuel. Also, the emissions measured are only those required in the regulations. The effects of variable fuel composition and especially that of fuels from unconventional crude oils are areas that need to be addressed. As direction is given on the probable acceptance of this engine into the Army system, such fuels-emissions work will be conducted.

State officials in the several states where vehicle emissions are monitored regularly have been contacted and their statements reveal that state controls only apply to vehicles registered in the individual state. Since Army vehicles are not registered with the state, the Army equipment does not fall under state jurisdiction. In addition, Army tactical and combat equipment is exempt from regulation since it is generally considered off-road, construction, tracked, or special-purpose equipment. Those vehicles which are commercial gasoline powered are purchased with certified "Clean Air Packages" on them and are thus acceptable. As a result, the various states consider the Army to be *within regulations* on the commercial equipment and *out-of-jurisdiction* on tactical and combat equipment. The Army is generally considered to be a *good neighbor*.

This atmosphere was also observed and expressed by the military personnel in the states where regulations are enforced. Problems with "Clean Air Package" equipped vehicles was a fairly common complaint, but good relations with the state regulatory agencies have been experienced. Most maintenance personnel are concerned about improving economy and readiness and would like to see improvements in the driveability of the commercial sedans, vans, and trucks.

Another area of activity is the preparation and maintenance of a data file on the emissions regulations in the various states. This data file has been stored in a Tymshare computer and is also available as an up-to-date loose-leaf notebook where all pertinent data are listed. The computer file can be accessed by AFLRL personnel or by others if the coded password is known. This file is kept current by AFLRL.

SUMMARY

The Army is presently active in a variety of programs to evaluate and determine the conditions which minimize pollution from Army mobile sources. The areas of research active or planned are:

- Extention of oil drain interval with better lubricants to reduce waste and disposal problems;
- The potential application of rerefined oils to minimize waste and disposal problems;
- The relationship between alternate fuel composition and exhaust emissions from Army equipment;
- Determination of the fuel-emissions relationships in candidate engines such as the stratified charge system;
- Modification of hardware to minimize blowby, thus reducing hydrocarbon emissions and prolonging lubricant life;
- Maintenance of data files on state regulations for emissions; and
- Monitor fleets of Army vehicles for emissions and fuel economy with exhaust emissions analyzers to establish statistical data on maintenance costs, fuel economy, and stability of emissions devices.

This work is part of the on-going fuels and lubricants research program conducted at AFLRL under the direction of MERADCOM, Energy and Water Resources Laboratory, Ft. Belvoir, Virginia or under contracts with TARCOM or TARADCOM, Warren, Michigan.

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